Martin Blank, Ed., *Electricity and Magnetism in Biology and Medicine*

CONDUCTING SOCKS ELIMINATE ANKLE SAR IN A FULL-SIZE MODEL EXPOSED TO NEAR-FIELD IRRADIATION AT THREE RADIOFREQUENCIES

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Radiofrequency (RF) currents induced in ankles and wrists near transmitting antennas can produce localized specific absorption rates (SARs) that exceed present guidelines even though whole-body average SAR is well within those guidelines. We tested the concept of conductive socks to prevent ankle SAR at three frequencies in the high-frequency (HF) band using a full-size human model near a monopole antenna. Our results showed that a conductive ripstop nylon sock effectively prevented any irradiation-induced temperature rises in the model's ankle as compared with the unprotected ankle.

Electromagnetic energy such as radiated from shipboard antennas or RF heat sealers, induces heating in personnel due to currents flowing in the body.[1] Wrist and ankle currents may generate relatively high specific absorption rates (SARs) due to the high current densities in small cross-sectional areas of the limbs.[2] The objective of this study was to determine whether a conducting sock surrounding a simulated ankle would reduce RF-induced heating. We have previously observed that conductive gloves eliminate RF burns about Navy ships, and we hypothesized that conductive socks would reduce ankle SAR by virtue of the "RF skin effect." In humans, ankle heating is a highly subjective sensation; therefore, this study was conducted to test our hypothesis quantitatively.

METHODS AND PROCEDURES

We measured local SAR in the restricted leg of a full-size muscle-equivalent human model at an outdoor groundplane irradiation facility.[3] The model was suspended from a plastic pipe stand in an upright position with the model legs touching the groundplane. We determined SAR from temperature-rise measurements obtained with nonperturbing temperature probes.[4] The model was exposed to continuous wave (CW) irradiation 1.2 m from a 10.8m whip antenna operating with a transmitter power of 1000 W at 10.2550, 16.6857, and 29.9000 MHz. (We frequently use this location relative to the antenna to provide a common reference among different experiments.) We compared an ankle covered by the conductive material with an uncovered ankle. The "anti-SAR" sock was constructed of silver/copper coated nylon cloth (Fiber Materials, Inc.). The sock covered the lower 33 cm of the model's left leg and was pinned at the top with common metal stick pins to insure conductive contact through the plastic model bag. The model leg is shown in Fig. 1. A 6cm-diameter simulated ankle was formed by constriction of the lower leg with duct tape. To measure the heating rate, the thermometer probe was inserted into the center of the constriction and allowed to stabilize for a few minutes. Then, a 15min preirradiation baseline was obtained by temperature recording at 1min intervals. Next, the model was irradiated for 15 min with the same sampling intervals. Corrections were made to the heating slope by subtraction of the baseline slope, and SAR was calculated from the resultant RF-induced slope.

RESULTS AND DISCUSSION

Table 1 shows the localized SARs along with previously measured E-field intensities at the selected location. Figure 2 shows the 29.9000MHz data and the dramatic lack of heating with use of "anti-SAR" sock. Although only three HF frequencies were used, we believe that these results are valid over a wider frequency spectrum because the phenomenon of the RF skin effect has been known to exist over many decades.

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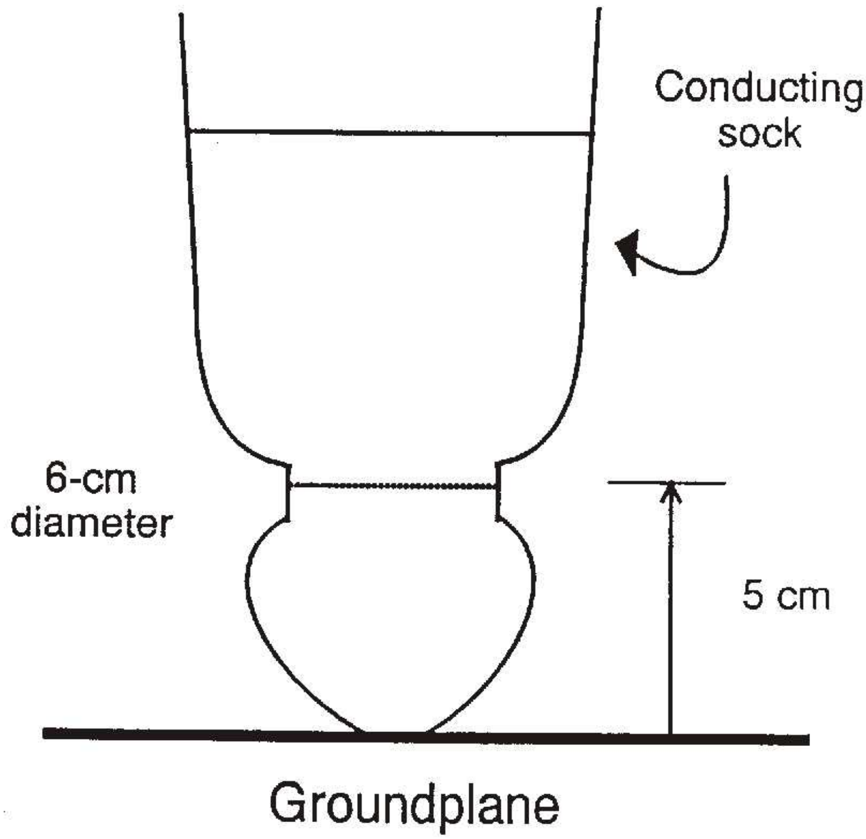

FIG. 1.—Diagram of model's simulated ankle.

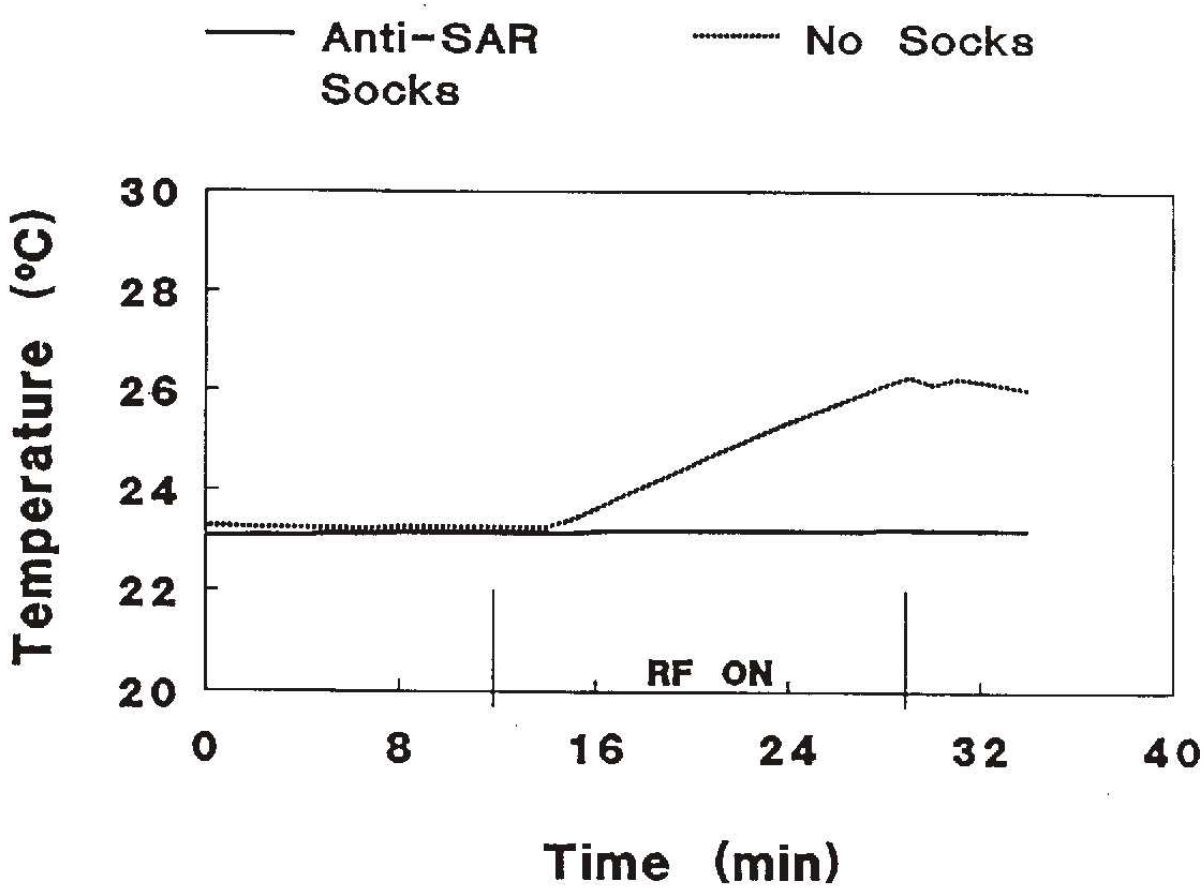

FIG. 2.—Ankle heating in model at 29.9000 MHz.

TABLE 1.—Localized SARs and E-fields.

Frequency (MHz)	Ankle SAR (W/kg) (N = 1)		E-field* (V/m)	
	Socks	No socks	Total	Vertical
10.2250	0	1.0	211	172
16.6857	0	3.9	332	220
29.9000	0	14.4	225	133

*Average of measurements at heights of 0.91, 1.37, and 1.82 m.

CONCLUSIONS

We conclude that conducting socks might be a practical method of reducing localized SAR in workers who must remain near RF emitters. The ripstop nylon used in this study would not be appropriate as a regularly worn garment; some type of conductive elastic textile is needed in order to produce a truly practical solution to the problem of excessive ankle SAR.[5]

REFERENCES

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5. This research was sponsored by the Naval Medical Research and Development Command under work unit 63706N M000096.004-7102 DN241516. The views expressed in this article are those of the authors and do not reflect the official policy or position of the U.S. Department of the Navy, U.S. Department of Defense, or the U.S. Government.